REMARKS

Reconsideration of the pending application is respectfully requested in view of the foregoing amendments and the following remarks.

Status of the Application

Claims 1, 3-5, 7-9, 13, 15-17 and 20-23 are currently pending, with claim 1 being amended herein. As the subject matter of amended claim 1 is fully supported by the application as filed, no new matter has been introduced into the application by way of these amendments.

Summary of the Office Action

Claims 1, 3-5, 7-9, 15, 16, 22 and 23 are rejected under 35 U.S.C. §101 as being directed to nonstatutory subject matter.

Claims 1, 3, 8, 13, 15 and 16 are rejected under 35 U.S.C. §103(a) as being unpatentable over the combination of Chang et al., *Radiology Image Orientation Processing for Workstation Display*, Part of the SPIE Conference on Image Display, SPIE Vol. 3335, 285-296 (February 1998) (hereinafter "Chang"), which references Glicksman et al., *Architecture of a High Performance PACS Based on a Shared File System*, SPIE Vol. 1654 Medical Imaging VI: PACS Design and Evaluation, 158-168 (1992) (hereinafter "Glicksman"), U.S. Patent No. 5,970,182 to Goris (hereinafter "Goris") and Wuscher et al., *Robust Contour Decomposition Using a Constant Curvature Criterion*, IEEE Transactions On Pattern Analysis and Machine Intelligence, Vol. 13, No. 1 (January 1991) (hereinafter "Wuscher").

Claim 4 is rejected under 35 U.S.C. §103(a) as being unpatentable over the combination of Chang, Goris, and Wuescher in further view of U.S. Pub. No. 2003/0215119 to Uppaluri (hereinafter "Uppaluri").

Claim 5 is rejected under 35 U.S.C. §103(a) as being unpatentable over the combination of Chang, Goris, and Wuescher in further view of U.S. Patent No. 5,572,565 to Abdel-Mottaleb (hereinafter "Mottaleb").

Claim 7 is rejected under 35 U.S.C. §103(a) as being unpatentable over the combination of Chang, Goris, and Wuescher in further view of Pietka, *Image Standardization in PACS*, Handbook of Medical Imaging, Academic Press (2000) (hereinafter "Pietka").

Claims 22 and 23 are rejected under 35 U.S.C. §103(a) as being unpatentable over the combination of Chang, Goris, and Wuescher in further view of U.S. Patent No. 5,943,446 to Pulsipher (hereinafter "Pulsipher").

Discussion

35 U.S.C. §103(a) Rejection of Independent Claim 1

Claim 1 is rejected under 35 USC §103(a) over a combination of Chang, Goris and Wuescher. *See* Office Action, page 4. The Office Action relies on Wuescher for the following features of claim 1, which are absent from the combination of Chang and Goris:

(a) "performing first and second derivative vector computation for one or more pixels of said digital representation;"

(b) "quantizing a direction and magnitude of the computed first and second derivative vectors;"

(c) "weighted voting of quantized first and second derivative directions into analyzing coordinate system orientations to determine a maximum vote;" and

(d) "selecting the image orientation having the maximum vote."
See Office Action, page 5.

However, Wuescher solves an entirely different problem and it is not concerned with image orientation. Hence, Wuescher is limited to scalar values having no direction component (as compared to "*vector*" values having a "*direction*" component recited in claim 1). Therefore, as discussed in further detail below, Wuescher does not teach or suggest elements (a) – (d) of claim 1 recited above.

Specifically, Wuescher aims at detecting and matching similar curves in a stereo pair of images. *See, e.g.,* Wuescher, page 41, left column, Introduction section. The approach

taken does not match individual points of the curve as is done traditionally, but instead matches similar segments of a curve. To this purpose, the curves, extracted by an edge detector in both images, are decomposed into primitive segments, such as line segments and circle arc segments. An example is illustrated in Figure 13 of Wuescher, wherein a contour of an object is completely segmented into the following primitives: linear curve segments that have a constant curvature of zero along its participating pixels (because the segment is everywhere locally straight), circle segments that also have a constant curvature c along its participating pixels, with the curvature value equal to the reciprocal of the circle's radius. *See*, Wuescher, page 46. Hence, a histogram of curvature values for the example of Figure 13 in Wuescher will have two peaks at 0 and c. Therefore, curvature in Wuescher is restricted to the scalar value alone.

The problem solved by the subject matter of the present application, is substantially different from the problem of Wuescher because the former aims at inferring the global orientation of an image, rather than detecting similar curves in a stereo pair of images as in Wuescher. The subject matter of the present application employs a voting strategy based on the ensemble of computed curvature vectors and their quantized orientation, and uses the maximum vote to infer the *orientation* of an image. Hence the histogram accumulators of the application will keep the orientation of the vector of curvature at all points of the contour. Curvature of the application is the magnitude of the vector and the *orientation* of the curvature vector. By contrast, the orientation is not computed nor suggested in Wuescher because it is not needed for detection and matching of similar curves in a stereo pair of images performed by Wuescher.

Furthermore, Applicants respectfully turn the Examiner's attention to additional differences in overall strategy between Wuescher and the current application. Wuescher "extracts extended, contiguous, constant curvature segments at several layers of detail. *See* Wuescher at page 42, right column, paragraph 1, line 5. However, the current application infers the main orientation of the object and does not assume that curvature is constant along a certain segment. Instead, curvature may be non-constant between different points of the contour, and the curvature magnitude is used as a weight of the associated curvature orientation. Constant curvature segments are mostly present only in man-made objects. The current application considers real world objects (such as the breast skin line in mammography

or the rib contours in thorax radiography and the specific anatomy) does not exhibit a pre-defined and constant shape characteristic, and hence cannot be represented as a set of primitives with constant curvature, as in Wuescher.

The foregoing steps (a) – (d) of claim 1 recited above are analyzed below in more detail.

I. "*Performing a first and second derivative vector computation for one or more pixels of said digital representation*"

The Office Action cites equation 3.2 on page 43 of Wuescher as allegedly meeting this step of claim 1. *See* Office Action, page 6. However, this equation in conjunction with equation 3.1 is the formula for curvature of a one-dimensional function where $\kappa(x)$ is a scalar value. It is not applicable to planar curves in two dimensions, where the curvature result is a vector with magnitude and orientation. The images considered are 2D and 3D images where 2D vectors respectively 3D curvature normal vectors are computed.

II. "*Quantizing the direction and magnitude of computed first and second derivative vectors"*

The Office Action relies on equation 3.1 on page 43 as allegedly meeting this step of claim 1. However, equation 3.1 of Wuescher does not imply a quantization, and as explained above with respect to the previous step, represents the scalar curvature value for one-dimensional curves y(x) without a direction component.

III. "*Weighted voting of quantized first and second derivative direction into analyzing coordinate system orientations so as to determine a maximum vote*"

In Wuescher, "[e]ach point casts votes for all curvature values within +/-tc of its own" and curvature is quantized "into bins of width 0.01." *See* Wuescher, page 45, section B, line 11, figure 10. The curvature voting in Wuescher is used to group the contour pixels that have similar curvature values. The curvature quantizer step tc is used as a tolerance to include (or exclude) contiguous points in the constant curvature segment. The quantization is a tolerance measure and hence has another meaning than quantization in terms of "the binning" of size of the orientation of curvature vectors in the present application. Hence in Wuescher, binning"

of the curvature magnitude (a scalar) is used, whereas in the present application binning of the curvature orientation (a vector) is used. The curvature magnitude in Wuescher is dimensionless, whereas the curvature orientation in the present application is expressed in degrees or radians.

IV. "*Selecting the orientation having the maximal vote*"

The Office Action cites the phrase "peaks of the resulting histogram represent curvature values most likely to fit the longest horizontal segments of the curvature plot" at page 45, section B, line 15 of Wuescher with respect to this step. In the present application, no peaks of the resulting histogram of curvature values are computed. Instead, the counts in the quantized orientation bins are examined and the orientation of the largest value is taken as the orientation of the image. In the applications of mammography and thorax radiography, these orientations are 90-degree orientations associated with the position of the anatomy in the image (e.g., a mammogram with thorax side aligned the left image border, or thorax radiography displayed in upright position). No curvature plot is made nor a fit of the longest horizontal segments (which would represent the constituent primitives of the object contour).

In summary, since Wuescher does not compute image orientation, it does not teach or suggest the foregoing features of claim 1. The remaining references, Chang and Goris, likewise do not teach or suggest these features, as correctly stated on page 5 of the Office Action. Thus, withdrawal of the objection of claim 1 and those dependent thereon is respectfully requested.

35 U.S.C. §101 Rejection of Independent Claim 1

Claim 1 has been amended herein to recite "determining, *via a computer for processing a digital representation of said image*, the orientation from direction and magnitude of normal vectors associated with local curvature in a set of points associated with the digital representation of said image by:". *See* Application, Abstract, page 4; *see also* Application, Figure 1 (representing image processing output via display and/or database storage).

The foregoing amendments tie the steps of claim 1 to a particular machine or apparatus (i.e., the "computer for processing a digital representation of said image"), as

required by the Federal Circuit's recent decision in *In re Bilski*. *See In re Bilski*, 88 U.S.P.Q.2d 1385 (Fed. Cir. 2008). Amendments to claim 1 further clarify that the remaining steps of "performing," "quantizing," "weighted voting," and "selecting" are performed by a special-purpose "computer for processing a digital representation of said image" that is specifically configured to process the digital image data as recited in claim 1. Further in line with *In re Bilski supra*, the "computer for processing a digital representation of said image" of claim 1 transforms the image data associated with a physical representation of a patient's anatomy (e.g., a radiographic image of a patient's breast) to a representation of the orientation of an object in the medical image. *See* Application, page 8 ("In order to determine the orientation of an object in a medical image, e.g. the thorax side of the breast mass, shape analysis techniques are used to describe the topology and characteristics of the object in the image.").

For the foregoing reasons, independent claim 1 meets the patentable subject matter requirements of 35 U.S.C. §101. Withdrawal of this rejection is respectfully requested.

Dependent Claims 3-5, 7-9, 13, 15-17, and 20-23

Dependent claims 3-5, 7-9, 13, 15-17 and 20-23 contain all of the limitations of the independent claim 1 from which they depend and, therefore, are patentable for at least the same reasons as their parent claim 1, discussed above.

Conclusion

As Applicant believes the application is in proper condition for allowance, the Examiner is respectfully requested to pass the application to issue. If, in the opinion of the Examiner, a telephone conference would expedite the prosecution of the subject application, the Examiner is invited to call the undersigned attorney.

Respectfully submitted,

/Christopher T. Griffith/

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